in the gold castings, and the armadillo pottery, a similarity which consists essentially in the use of detached figures, nodes and fillets, as described before. He also calls attention to the frequent occurrence of the head with upturned snout—the alligator-head design of painted pottery—in this technique, a feature that had escaped the attention of previous students. At least one of them has, however, the type of proboscis rolled down (Pl. 58, Fig. *g*) which is so common on the plateaus of Costa Rica. In this case also the rigidity of the fundamental form seems particularly suggestive to the writer, because a variety of animals have all been presented in analogous outlines.

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Principles of Chemical Geology. A review of the Application of the Equilibrium Theory to Geological Problems. By JAMES VINCENT ELSDEN, D.Sc. (London), F.G.S. London and New York, Whittaker and Co. 1911. 222 pages, with 44 figures.

While an imaginative geological writer has recently asserted that "to be more productive than it is, geology must become more speculative," it is gratifying to note the steady advance that is being made in the explanation of geological phenomena along the lines of established principles in the fundamental sciences of physics and chemistry. With the rapid development of physical chemistry there has been a corresponding improvement in conceptions regarding processes that have taken part in the production of the earth as we know it. And every effort that is made to place these fundamental concepts within the reach of students of geology, and which succeeds as well as the book before us, should be welcomed as a contribution of the first order to the advancement of the science.

But it must be borne in mind that any developing branch of human knowledge is an assemblage of observations and conclusions of variable degrees of accuracy and truthfulness, subject to constant revision and readjustment. And in the problem of the application of principles of physics and chemistry to the phenomena of the earth, as a whole, and in detail, these are the variable factors of divergent opinion regarding the laws to be applied, and the still very inadequate data relating to the phenomena to be explained, as well as an accumulation of conflicting observations and of conclusions, in some instances misleading or actually incorrect. Moreover the multitudinous requirements in each branch of learning prevent the worker generally from acquiring independent judgment in more than one distinct branch of science.

For these reasons each contribution to the solution of the highly complex problems to be found in the study of rocks and minerals must have its particular characteristics arising from the point of view and range of experience of its author, as well as from the source of his information and the quality of his judgment.

In the contribution made by Mr. Elsden there appears to be the experience of a physicist familiar with the subject of physical chemistry, and capable of presenting the essential principles in a clear and simple manner, not wholly free, however, from the technology of the science. There is less of the chemical side of the subject than the title of the book suggests, which might better have been "Principles of Physical Chemistry Applied to Geology," for there are phases of the chemistry of the earth not touched upon. The application of the principles discussed is well made in most cases, and the examples that may illustrate them are happily chosen from the mass of recorded observations to be found in the literature of geology and petrology. In the selection and rejection of conflicting opinions in certain instances the author's judgment has been on the side of the more probable—according to the opinion of the reviewer. But the author does not appear to possess personal knowledge of the petrographical and mineralogical data appealed to in illustration of particular principles.

The author states that one of the main objects he has had in view is to show that the

key to the solution of the problems in the physical chemistry of geology lies in the determination of the conditions of equilibrium of each set of actions, or states of existence, of the factors under discussion; and further that he has attempted rather to stimulate interest in this branch of geology than to provide a complete exposition of the subject. It appears that this attempt is eminently successful, and that students of geology and petrology will be greatly benefited by this presentation of the principles in question.

The book consists of 10 chapters dealing with (1) Equilibrium between the Crystalline and Amorphous States; (2) Equilibrium as Influenced by Viscosity; (3) Diffusion as a Factor of Equilibrium; (4) Surface Tension as a Factor of Equilibrium; (5) Vapor Pressure as a Factor of Equilibrium; (6) Equilibrium Conditions of Polymorphous Forms; (7) Equilibrium in Solutions; (8) The Eutectic Theory; (9) The Theory of Solid Solutions Applied to Geological Problems; (10) On the Conditions of Chemical Equilibrium in Geology.

Without undertaking to give a synopsis of the contents of these chapters, or to do more than express approval of the method of treatment with a recommendation that they be carefully studied by those interested in the subject, attention may be called to several instances in which the fallibility of the literature relied upon by the author may be illustrated, or to instances where it has been misinterpreted. In the Chapter on Viscosity the observation of Barus on the combination of water and glass at temperatures between 185° and 200° C. is cited, and the impression is given that it is an operation of unlimited applicability to all glasses. Whereas Barus subsequently found that other commercial glass did not combine with water under any conditions which his apparatus was able to impose. The general conclusion stated by Mr. Elsden as to the effect of water in solution in silicate magmas in reducing viscosity is, nevertheless, correct, as other observations have shown.

In connection with surface tension and its explanation of the growth of larger crystals at the expense of smaller ones the author has confused his citations by referring to a description of the obsidian at Obsidian Cliff, Y. N. P., by the reviewer, as containing a supposed application of the principle to the weathering of the laminated rock. There is no reference to weathering in the paper mentioned, and its author never entertained any such ideas as those implied in the comment by Mr. Elsden.

In the discussion of crystallizations in metastable and labile states of solution it is quite evident that the author is not relying on his own knowledge of rocks, but has been misled by the dogma of "first and second generations of crystals," when he states that "while the metastable state persists small crystals could not be produced," for nothing is commoner than seriate porphyritic fabric in igneous rocks, and the presence of various sized crystals of the same kind of mineral. His treatment of the subject of crystallization is not so satisfactory as that of other portions of his subject. And in the discussion of the amphibole and pyroxene series the lack of appreciation of the chemical phase of the problem is apparent.

Aside from these criticisms the book is a valuable contribution to the literature of geology, and should be studied by all who desire to understand the bearing of physical chemistry on the problem of the formation and alteration of minerals and rocks.

J. P. IDDINGS

THE RELATION BETWEEN THE COLORATION AND THE BATHYMETRICAL DISTRIBUTION OF THE CYCLOGASTERIDÆ

IN a recent article in SCIENCE[1] Dr. H. B. Bigelow gives a résumé of a preliminary report[2] by Dr. Johan Hjort on the results of the

[1] July 7, 1911.

[2] *Geographical Journal*, Vol. 37, 1911, pp. 349–377, 500–523. Not seen by the writer.